

OHIO AGRICULTURAL EXPERIMENT STATION

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MAY, 1888

The Spring and Summer Treatment of Apple Orchards to Prevent Insect Injuries. Experiments with Remedies for the Plum Curculio.

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Ohio Agricultural Experiment Station

BULLETIN No. 3

THE SPRING AND SUMMER TREATMENT OF APPLE ORCHARDS TO PREVENT INSECT INJURIES.

INTRODUCTION.

A large proportion of apple orchards of Ohio are today either in a dead or dying condition, or are producing only a small percentage of the marketable fruit which they ought to produce. That this is not necessarily the case is shown by the fact that here and there are seen large and thrifty orchards, many of them planted more than a quarter of a century ago, bearing regularly and well, and yielding to their owners a good profit on the time and money invested in them. I believe that in every case the reason for this difference will be found to be largely due to the difference in the treatment they receive. Those which are dead and dying will be found to be wholly neglected, or improperly cared for, while those which are living to a vigorous and green old age receive the attention they need. There was a time in the early history of this region when fruit trees seemed to grow as naturally and well as the oak in its native forest, but that day has long since gone by; and the successful orchardist of the present must do something more than stick his trees carelessly in the ground, leaving them to have their bark girdled by mice and rabbits, their trunks eaten by borers, their leaves sucked dry by plant lice, or devoured by canker-worms and leaf-rollers, and their fruit, if happily they should survive to produce any, ruined by apple-worms, or stung by curculios. And with present prices for orchard products, the fruit grower can well afford to go to some trouble and expense to keep his trees thrifty, and prevent insect injury to the fruit.

In the following pages I have endeavored to condense into a brief practical manual the most approved methods of fighting orchard insects; and have placed at the end a chronological summary of the treatment likely to be needed each season when these insects are destructively numerous.

The insects injuriously affecting the apple orchards of Ohio may be conveniently divided into three classes, viz.: (1) Those affecting the trunk; (2) Those affecting the foliage; and (3) Those affecting the fruit.

Under this head come those well-known pests—the apple tree borers and the bark-lice. The former are practically of two kinds—the Round-headed apple tree Borer (*Superda candida*), and the Flat-headed apple tree Borer (*Chrysobothris femorata*); and the most injurious species of the latter is the Oyster-shell Bark-louse (*Mytilaspis pomorum*).

ROUND-HEADED APPLE TREE BORER.

The three later stages of this insect are shown at Figure 1. The beetle (*c*) is easily recognized by the brown color of its body, and the two conspicuous longitudinal whitish stripes along its back. It appears early in summer and deposits its eggs on the tree trunks, in or under the bark, within a few inches of the ground, frequently placing them just above the soil surface, or even below it where the ground is cracked open so that the beetle can descend without difficulty. The insect makes a slit-like opening in the bark into which the egg is pushed. A few days later the egg hatches into a larva or grub, which gnaws its way into the inner bark or sap-wood, where it continues to feed throughout the season. As winter approaches it frequently burrows downward below the surface of the ground, and rests there until spring, when it again works



FIGURE 1.

upward and gnaws the inner bark and sapwood as before. It rests again the following winter, and in the spring gnaws its way deeper into the body of the trunk, cutting cylindrical channels in every direction. Late in summer it bores upwards and outwards to the bark, lining a cavity at the end of its burrow with dust-like castings, and there rests until spring, when it changes to the dormant chrysalis state (*b*). The adult beetle emerges from the chrysalis about a fortnight later, eats a hole through the bark with its strong jaws, and comes forth to continue the propagation of the species. Thus three years are required for the development of the insect.

The place where the larva enters may frequently be detected, especially in young trees, by the sawdust-like castings that are pushed out. The eggs also may often be seen, and are easily destroyed by pressing on the bark surrounding them with a knife-blade or some similar instrument. The presence of the larva is shown later by the discoloration of bark where it is at work.

The full grown grub or larva of the Round-headed borer is illustrated at *a* Fig. 1. It is about an inch long, wholly without feet, whitish, with a chestnut-brown head and black jaws. The pupa or chrysalis (*b*) is lighter colored than the larva, and has numerous small spines on its back.

FLAT-HEADED APPLE TREE BORER.

This insect is very different both in its adult and larval states from the one just discussed. The adult beetle instead of being cylindrical in form and brown in color, is flattened and greenish black. It appears, however, at about the same season as the other, and the life histories of the two species are in general much alike, the chief difference being that the present species requires less time to develop, and attacks the tree higher up, being found all the way up the trunk, and frequently in the larger branches.

The front end of the larva, which is illustrated at Figure 2, *a*, is enlarged and flattened while the rest of the body is much narrower, and tapers slightly towards the posterior extremity. It is pale yellow in color and has no feet. The pupa (*b*) is at first whitish, but becomes darker as the beetle develops. As noted above the adult beetle (*d*) is of a shining, greenish black color, and has short stout legs. It may often be seen basking in the sunshine in summer on the sides of trees and logs.

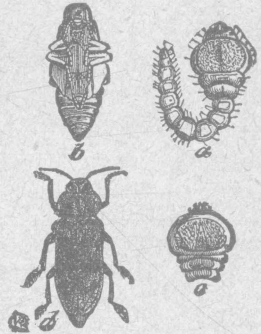


FIGURE 2

The eggs of this insect are deposited early in summer in the crevices, and under the scales of the bark, being fastened in place by a glutinous substance. In a few days the larva hatches and bores through the bark to the sapwood, in which it cuts broad flat channels, and sometimes completely girdles the tree. As it develops it bores farther into the solid wood, and when full grown again approaches the surface. When ready to become a pupa it gnaws partially through the bark, and then casts its last larval skin. About a fortnight later the pupa changes to a beetle which gnaws its way through the bark, and thus completes the cycle of development.

REMEDIES.

Fortunately the injuries not only of both of these borers, but also of the bark-louse discussed below, may be prevented by a single easily applied remedy. It consists simply in applying late in May, or early in June, and again about three weeks later, a strong solution of soft soap, to which has been added a little crude carbolic acid. This mixture may be conveniently made by mixing one quart of soft soap, or about a pound of hard soap, with two gallons of water, heating to boiling, and then adding a pint of crude carbolic acid. The solution should be thoroughly applied, (a scrub brush is excellent for the purpose) to the trunk and larger branches of the tree. If the bark of the trees is especially rough it should be scraped before the wash is applied; and the soil should be smoothed down about the base of the trunk, so that there will be no cracks for the insects to enter to deposit their eggs. Of course the object of this application is to prevent the laying of the eggs from which the grubs hatch. As an additional precaution it is well to examine the trees during the late summer and early autumn months for eggs and young grubs, which are readily detected, and can be easily destroyed with a knife. In this way one man can go over an orchard of five hundred or more young trees in a day.

APPLE TREE BARK-LOUSE.



A piece of bark covered with the scales of this insect is represented in Figure 3. If one of these scales be raised early in the spring there will be found beneath it a mass of yellowish or whitish eggs, which hatch about the middle of May into small lice, which appear as mere specks to the naked eye. These move about over the bark a few days, when they fix themselves upon it, inserting their tiny beaks far enough to reach the sap. Here they continue to increase in size, and by the end of the season have secreted scaly coverings like those shown in the illustration.

As has been mentioned above the soap wash recommended for the prevention of borers also effectually destroys this pest. The mode and time of application for the two kinds of insects is the same.

AFFECTING THE FOLIAGE

There are two principal classes of insects which attack the foliage of apples, viz.: plant-lice, and leaf-eating caterpillars:

APPLE PLANT-LOUSE.

Although this insect (*Aphis mali*) has been known to science for more than a century, we are yet ignorant of some important details of its life-history; but what we do know may be briefly summarized as follows: The lice hatch from eggs in spring as soon as the leaf-buds begin to expand, and increase with marvelous rapidity so that almost as fast as the leaves develop there are colonies of the plant-lice to occupy them. They continue breeding on apple until July, when they largely leave the trees, and, as we suppose, migrate—we know not where, but probably to some annual plant that is succulent in midsummer. Here, apparently, they continue breeding until autumn, when they return to apple and the winged females may be found establishing colonies of the wingless egg-laying form upon the leaves. The males are apparently developed on the same plant that the winged females are, as in thousands of colonies examined in October and November, 1887, not a single immature male specimen was seen. The small oval eggs are now laid on the twigs and buds, and the cycle for the year is complete. It will at once be seen that from an economic standpoint it is very important that the missing links in the chain of this insect's life-history be found, for until this is done we are not sure that the remedies proposed are the best ones possible. As Professor Forbes has well remarked, „The life-histories of insects lie at the foundation of the whole subject of economic entomology, and constitute in fact the principal part of the science; for until these are clearly and completely made out for any given injurious species, we cannot possibly tell when or how to strike it at its weakest point.”

REMEDIES.

The best topical applications for the destruction of plant lice are kerosene emulsion and tobacco decoction. The former is made by adding two parts of kerosene to one part of a solution made by dissolving half a pound of hard soap in one gallon of boiling water, and churning the mixture through a force pump with a rather small nozzle until the whole forms a creamy mass which will thicken into a jelly-like substance on cooling. The soap solution should be hot

when the kerosene is added, but of course must not be near a fire. The emulsion thus made is to be diluted before using with nine parts cold water.

The tobacco decoction is made by soaking refuse tobacco stems in hot water, and then draining off. The liquid thus formed is a very efficient plant-louse destroyer.

These substances should be applied where the lice are very numerous, early in the season, by means of a force pump and spray nozzle.

APPLE-LEAF CATERPILLARS.

There are many species of caterpillars which devour the foliage of the apple, but in general their life-histories are alike and the methods of fighting them are much the same. Of the most injurious ones especial mention may be made of the canker-worm, tent caterpillar, tussock-moth (*Orgyia leucostigma*), leaf-skeletonizer (*Pempelia hammondi*), and the various apple-leaf rollers. Many of these have been discussed at length in previous publications of this Station, and the rest are treated of in the standard works on entomology.

Fortunately nearly, if not quite all, of the insects devouring the leaves of apple may easily be destroyed by the application of London purple or Paris green to the foliage in May or June,—just the time when we spray for the codling moth, so that the same application destroys the two classes of insects, and hence it is of two-fold benefit. Where the canker-worm is numerous, however, it is sometimes necessary to poison the foliage earlier than the spray for the codling moth is applied, thus necessitating two sprayings only a short time apart. I think it very probable, though, that it will pay better to head off the canker-worms with bands of paper covered with tar,* and thus avoid the necessity of spraying so early, when the foliage is very tender, and more susceptible to injury from the poison than it is later.

AFFECTING THE FRUIT

The insects that are especially injurious to the fruit of the apple are the codling moth or apple worm, the plum and apple curculios, and the apple maggot. In this connection we can only discuss at length the first mentioned pest.

THE APPLE WORM, OR CODLING MOTH.

Professor S. A. Forbes, the State Entomologist of Illinois estimates that for that State alone there may fairly be attributed to the depredations of this insect an annual loss of four and three-quarter

*See Report of this Station for 1886, p. 205.

millions of dollars (\$4,750,000); and probably the loss in Ohio is equally great, if not greater. Fortunately, however, it has been conclusively proven that a large proportion of this loss may be saved by the simple process of spraying the trees early in the season with a mixture of London purple or Paris green and water, in a manner presently to be described.

The life-history of the codling moth is too well known to need more than the briefest recapitulation. The small chocolate moth

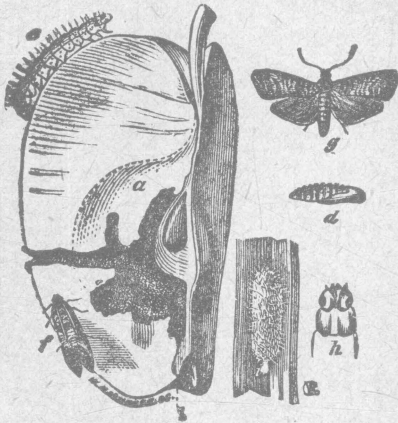


FIGURE 4.

(*a*, Fig. 4) deposits its eggs in spring in the blossom end of the young apple, before the latter has turned down on its stem. From this egg there hatches a small worm or caterpillar, which nibbles at the skin of the fruit and eats its way toward the core. Here it continues feeding as the apple develops, increasing in size until at the end of three or four weeks it is about three-fourths of an inch long, and appears as represented at *c*. It has now finished its caterpillar growth, and leaving the apple finds

some crevice in the bark where it spins a rather slight silken cocoon which it changes to a pupa. It remains in this condition about a fortnight, when it emerges as a moth like the one by which the original egg was laid. Thus the life cycle is completed. There are at least two broods in a season.

THE REMEDY.

There is now known but one generally successful practical means of preventing the injuries of the codling moth, and that is the method of spraying with the arsenites mentioned above. That this is a successful preventive the sciences of entomology and horticulture both attest; and there is now no good reason why the fruit growers of Ohio should permit the destruction of a large proportion of their fruit by this little pest.

This remedy has been in use for years by A. R. Whitney, Esq., one of the leading growers of Northern Illinois, and also in the large orchard regions of Western New York. More recently it has been brought into prominent notice by Professor A. J. Cook of the Michigan College, Professor S. A. Forbes of Illinois and a score of other scientific and practical men.

The essential point in this method of treatment is to have a small quantity of poison lodge in the depression in the blossom end of the apple before it turns down on its stem, the supposition being that when the newly hatched caterpillar gnaws the skin preparatory to entering the fruit, it will eat sufficient poison to be killed. This end is best accomplished by applying the poison in a water spray by means of a force pump and spray nozzle, throwing the liquid above the tree so that it will settle in a fine mist. This should be done just after the blossoms have fallen, when the apples are about as large as peas. I believe that generally speaking one application will answer the purpose very well, unless there is a washing rain soon afterwards, in which case the application should be repeated.

I prefer London purple to Paris green, as it is cheaper, less liable to scorch the tree more readily kept in suspension. A safe and effective proportion is three-fourths of a pound to eighty or one hundred gallons of water. Paris green may safely be used in the proportion of one pound to one hundred gallons of water. The poison should be formed into a paste with a little water, before stirring into the larger receptacle.

Of course it must be remembered that these substances are deadly poisons; all reasonable care should be taken that no accidents occur through their use. Protect the hands of the operator with close-fitting gloves, and apply the spray so that it will not be breathed by men or horses. Keep stock out of orchard for some time after the application is made, and do not spill the poison in quantity on the ground where it will be accessible to animals of any kind. Always keep the poison itself in tight vessels, plainly labeled POISON, and out of the reach of children.

No danger need be feared from eating mature apples that were poisoned when the size of peas, for chemical analysis has shown that the extremely small amount of poison that lodges on the fruit is dissipated long before it matures.

SOME PRACTICAL EXPERIENCE.

To convince the fruit growers of Ohio that this remedy is a practical one for use by practical men, I present below the experience of some of the prominent fruit growers who have tried it.

A C. Hammond, Esq., Secretary of the Illinois State Horticultural Society, a fruit grower of long experience in one of the largest fruit regions in the west, in a letter to me says:

"I have been experimenting with liquid poisons in the orchard this season with wonderful success. I have just been gathering the apples from an orchard which was sprayed twice with London purple, and have between 400 and 500 bushels of high-colored perfect fruit. And if all the perfect apples within ten miles of me were collected, they would not make as many bushels as this orchard, which seems plainly to indicate that there can be no other cause for my success.

A Michigan correspondent of the *Farmer's Review* (April 6, 1887), says:

"**We sprayed at the same time when the fruit was the size of peas, no larger, and it was emphatically the thing. The yield was immense, of good sound fruit, and bushels of apple never a worm. It seemed miraculous. I advise every one who owns an apple tree to spray it with a solution of Paris green."

An Ohio correspondent of the *Ohio Farmer* writes:

"Being fully convinced of the necessity of combating insects injurious to the apple last spring, such as codling moths and canker worms, I procured a Little Giant Atomizer with Climax nozzle and went to work. This machine is nicely mounted upon three wheels, and the tank holds about 40 gallons of water, so it may be drawn about by hand or placed in a wagon-box and one or two horses used. I used London purple instead of Paris green on most of the orchard, as it is lighter and remains in suspension in the water much better than the green, and answers every purpose. I used three-fourths of a pound to a tank full of water (40 gallons), which I found to answer the purpose very well. Where the canker worm was very bad I used one pound. I used the atomizer in a wagon, as I could do my work much more quickly this way. Myself and assistant sprayed 200 very large trees in three-quarters of a day in this way.

"I only applied the poison once (the 11th of May), but the good effect was very noticeable all summer, and especially in the fall; for while my crop of apples was not as large as it would have been, if I had sprayed them earlier and oftener, the apples were very fine and perfect in appearance, not being stung by insects, causing hard lumps, or wormy and rotten. I took ten premiums at the State Fair last fall, while my neighbors had no apples worth mentioning. I attribute my success wholly to the use of the poison before mentioned, and believe that this is a sure way, as far as insects are concerned to raise a good crop after they have once formed upon the tree."

Professor E. A. Popenoe, of the Kansas Agricultural College, writes:

"The bearing trees throughout [the College orchard] were sprayed in spring with London purple, and were afterwards banded to test again the value of this treatment in reducing the number of the codling moth larvae and wormy apples. The result confirmed the conclusion drawn from our previous tests in the same line, that over seventy-five percent of the crop is thus saved from this insect."

Mr. Frank Dill of Franklin County, Ohio, has sprayed; under the direction of this Station, an orchard of some twenty-five acres for the last two years and informs me that he has thus been very successful in raising fine, sound fruit, which competes successfully with

New York apples in the Columbus market. Mr. A. J. Gantz, of the same county, has also sprayed his orchard, at the advice of this Station, and reports similar gratifying results.

And, finally, of the many other similar experiences at our command, we have only space to mention the conclusive experiments made in Illinois by Prof. S. A. Forbes, covering a period of two years, in which nearly 40,000 apples were examined separately, the result arrived at being that "at least seventy percent of the loss commonly suffered by the fruit grower from the ravages of the codling moth or apple worm may be prevented at a nominal expense or practically in the long run at no expense at all, by thoroughly applying Paris green in a spray with water once or twice, early in spring, as soon as the fruit is fairly set, and not so late as the time when the growing apple turns downward on the stem." *

INSECTICIDE APPARATUS



FIGURE 5.

The apparatus needed for the application of insecticides in the apple orchard will vary somewhat with the size and number of the trees to be treated. The simplest spraying machine consists of a hand force pump with spray nozzle, attached to a tank or barrel containing the insecti-

cide solution. For orchard work this can be placed in a wagon and driven along beside the trees as shown in Figure 5.

There are a number of forms of spraying machines upon the market, most of which do good work, and serve the purpose very well. We mention and illustrate herewith a few of the leading practical machines of this kind.

*Bul. No. I, St. Ent. Ill. p. 11.

The "Perfection spraying outfit manufactured by the Field Force Pump Co., Lockport, N. Y., is illustrated at Figure 6. It consists of a hand force pump which sets upon a barrel, has ten feet of discharge hose and a graduated spray nozzle attached. At "B" three feet of return hose is attached which connects with a discharge pipe at the lower end, so that at every stroke of the pump a small part of the liquid is redischarged, thus keeping the poison well mixed. The price of the outfit, without barrel, is \$12.00

A similar hand force pump is the Climax Double-Acting Force Pump, manufactured by the Nixon Nozzle and Machine Co. of Dayton, Ohio. It can be attached to a barrel or other vessel and two jets of liquid can be thrown at the same time if desired. The pump alone

costs \$9.00, and a brass screen connection to attach it to a vessel is 50 cents extra. Besides this there will be needed hose and nozzles, so that the outfit complete costs about \$11.00.

A pump for spraying trees, as well as for other purposes, is manufactured by P. C. Lewis, Catskill, N. Y., and sells for \$6.00. This machine is highly recommended by those who have used it.

A series of spraying machines are also manufactured and sold by the Goulds Manufacturing Company of Seneca Falls, N. Y. We have not seen or used any of these, but from the illustrations and descriptions should judge that they would answer the purpose very well. The best one for orchard work is Gould's Double-Acting Spraying pump, the price of which is \$14.00 to \$16.00, according to

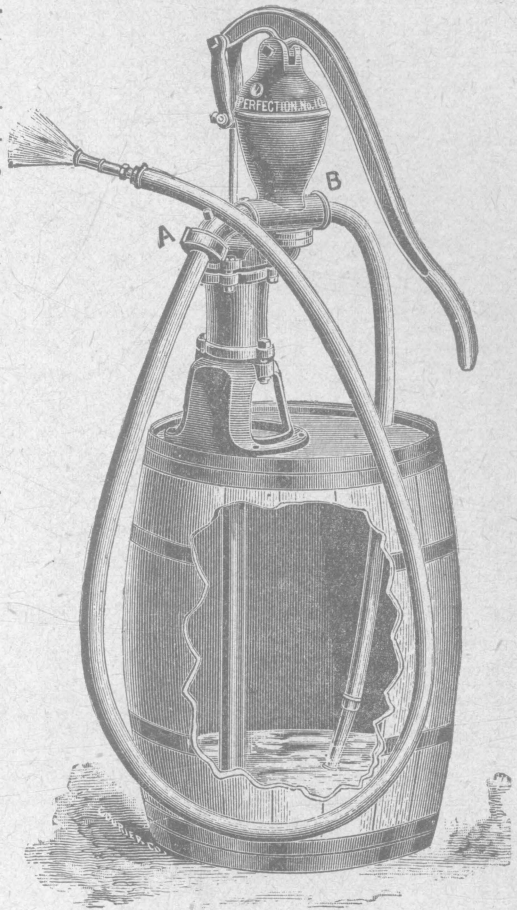


FIGURE 6.

the size desired. The Pacific Brass Force Pump, costing \$16.00, appears to be also an excellent machine for the purpose. For small trees the Portable Brass Aquaject, costing \$9.00, answers very well.



FIGURE 7

A machine to be operated by horse-power is shown at figure 7. It is manufactured by the Field Force Pump Co., and sold for \$30.00. The manufacturers claim that it mixes the fluid and keeps it stirred up in the tank while in operation, the pump being double-acting and having a double spout which supplies two discharge hose.

Figure 8 shows a barrel machine manufactured by the Nixon Nozzle and Machine Co. of Dayton, O., which is sold for \$35.00. "It is built on runners and can easily be drawn by one horse over any

land accessible for cultivation; or it can be placed in a wagon and used as readily for orchard work as any unmounted tank machine. It has a pendulum agitator arranged for stirring the liquid used as an insecticide." The "Little Giant" machine, made by the same firm for the same price, is much like this, except that the tank is square and is mounted on wheels.

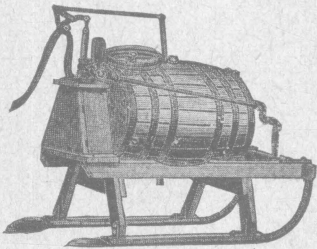


FIGURE 8

SPRAYING NOZZLES

There are many forms of spray nozzles upon the market nearly all of which do good work, but space forbids more than present mention of a few of the leading ones. One of the best for us in the orchard is the Climax illustrated in Fig. 9. The spray is obtained by throwing a small stream of water through the orifice shown in No. 2 against the wire netting shown at the upper end of No. 3. A great advantage of this nozzle, which is manufactured by the Nixon Nozzel and Machine Co., is that it will throw a spray for a considerable distance, often an important point in spraying large trees.

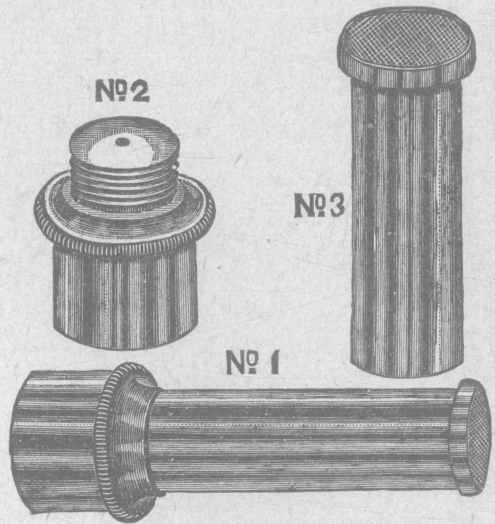


FIGURE 9

Figure 10 shows the "Boss" nozzle, made by the Field Force Pump Co. Another nozzle, made by the same firm, which is excellent for many purposes, is the "Graduating Spray Nozzle." It will throw a solid stream or a spray of any desired fineness. The "Deflector Spray and Solid Jet Hose Nozzle," manufactured by the Lowell Faucet Company, Lowell, Mass., is much like the one last mentioned. I have used it and found it very satisfactory.

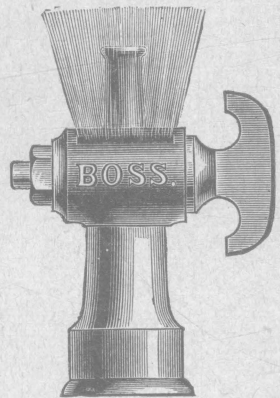


FIGURE 10

CHRONOLOGICAL SUMMARY

May. Spray trees with mixture of $\frac{3}{4}$ lb. London purple to 80 gals. water just after blossoms fall. About the same time wash trunks and larger branches with a mixture of soft soap, to which has been added a little crude carbolic acid. If plant-lice are destructively numerous spray early with kerosene emulsion or tobacco decoction.

June. If heavy rains have intervened, repeat early in the month the spraying with London purple. About three weeks after first application of soap wash, repeat it.

July to October. Examine trees once or twice for eggs and young of borers.

EXPERIMENTS WITH REMEDIES FOR THE PLUM CURCULIO.

There are three methods of preventing curculio injury to plums that I desire to see thoroughly and extensively tried in Ohio. So far as possible tests will be carried on at the Experiment Station, but as the facilities here are rather limited for this work, on account of the small size of the plum orchard, and as it is also desirable that they be tested in different localities and under varying conditions, the Station will be greatly obliged to any of the horticulturists of the State who will try either of the methods mentioned below, and report the results to us. Of course it is well known that plums may be successfully raised by jarring for the curculio, but it is very desirable that a simpler remedy be found.

I. Spraying with London purple or Paris green as soon as the blossoms fall, as recommended for the apple.

I am reliably informed by one of the largest fruit growing firms in Western New York that in this way they succeed in fighting the curculio and raise large crops of plums. The method has been recommended at various times for several years but as yet has received little attention.

II. Dusting the trees with air-slaked lime as soon as the blossoms fall, and repeating the application occasionally as the season advances-

I have seen the results of this treatment in the fruit-belt of Michigan where trees so treated were loaded with fruit wholly free from curculio injury. The lime was applied by means of a flat paddle from a barrel in a wagon which was driven along the rows of trees on the side towards the wind. It may also be applied in a water spray.

III. Planting native varieties of plums with the ordinary foreign ones.

This is the method which has been strongly advocated for several years by Mr. D. B. Wier, of Laco, Ill. His idea is that the curculios deposit their eggs in fruit of native varieties in preference to the others, and that only a small percentage of these eggs develop. I would be very glad to hear from any one having a plum orchard containing both sorts of trees already in bearing condition.

CLARENCE M. WEED, *Entomologist*.